As-Built Geotechnical Report For Emergency Stabilization

5700 Block Soledad Mountain Road, La Jolla, California

Prepared for | **October 14, 2010**

City of San Diego | **Volume 1 of 4**

Helenschmidt Geotechnical, Inc.

Helenschmidt Geotechnical, Inc.

October 14, 2010
107069

Jamal Batta
Project Manager
Transportation Engineering Division
City of San Diego
600 B Street, Suite 800
San Diego, CA 92101-4905

SUBJECT: As-Built Geotechnical Report for Slope Stabilization

RE: 5700 Block Soledad Mountain Road and Desert View Drive Alley
La Jolla, California

Dear Mr. Batta:

In accordance with your request and authorization, **Helenschmidt Geotechnical, Inc. (HGI)** has completed geotechnical testing and observation of construction for the emergency slope repair in the 5700 Block of Soledad Mountain Road and Desert View Drive Alley in the La Jolla area of San Diego, California. The emergency slope repair has included installation of 119 reinforced concrete shear pins, removal of landslide debris and reconstruction of the Soledad Mountain Road Right-of-Way, construction of a reinforced earth buttress in Desert View Drive Alley, surface and subsurface drainage improvements and slope re-grading in accordance with grading and construction plans developed by Helenschmidt Geotechnical, Inc. and City of San Diego requirements. The following, four volume report, presents a description of construction activities and the results of our observations and testing during construction.

We have appreciated the opportunity to provide our geotechnical services on this project. If you should have any questions regarding our report or other issues regarding the emergency slope repair, please call at your earliest convenience.

Respectfully,
Helenschmidt Geotechnical, Inc.

Stanley Helenschmidt
Principal Geotechnical Engineer
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AS-BUILT GEOTECHNICAL REPORT
FOR EMERGENCY STABILIZATION
5700 Block of Soledad Mountain Road,
La Jolla, California

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1.0 INTRODUCTION

1.1 Report Outline

The purpose of this report is to document geotechnical observation and testing performed during the repair of the Soledad Mountain Road Landslide which occurred on October 3, 2007. This report consists of four volumes. Volume 1 pertains to the stabilization and reconstruction of the Soledad Mountain Road Right-of-Way which traverses the headscarp region of the landslide. Design criteria for this portion of the landslide repair were previously presented in the report entitled ***Geotechnical Design Report for Shear Pin Landslide Stabilization of Soledad Mountain Road Right of Way, 5700 Block Soledad Mountain Road, La Jolla, California***, (Two Volumes), dated March 13, 2008, by Helenschmidt Geotechnical, Inc. (HGI).

Volume 2 pertains to geotechnical design of stabilization for the Desert View Drive Alley Right-of-Way and geotechnical observations and testing during implementation of those repairs. The Desert View Alley stabilization, for purposes of this report, includes reconstruction of the Desert View Drive Alley Right-of-Way located at the toe of the October 3, 2007 landslide, re-grading of the portion of the landslide mass located on private properties and the repaving of Desert View Drive Alley. To expedite construction, design recommendations for this portion of the landslide repair were not issued in a report prior to construction. Construction plans were developed based upon engineering analyses and our discussions with City of San Diego representatives and were detailed in ***Construction and Grading Plans For: Desert View Drive Alley Emergency Repair*** (20 sheets plus three delta plan changes on four additional sheets; total 24 sheets), dated October 20, 2008, prepared by Helenschmidt Geotechnical, Inc. The geotechnical and structural analyses utilized in development of the plans are presented in this report.

Appendices and plates relevant to Volumes 1 and 2 are presented in Volumes 3 and 4, respectively, including as-built geologic maps and cross sections, field test data, laboratory test data, reduced size plan sets, monitoring data and as-built geotechnical stability analyses.

1.2 Project Summary

The following report presents the results of our observation, testing and analysis during the repair of the landslide that occurred in the 5700 Block of Soledad Mountain Road, La Jolla, California (Figure 1). The landslide occurred at approximately 8.50 am on October 3, 2007. The landslide involved a block-glide type failure approximately 250 feet in width, and represents a partial re-activation of a larger ancient landslide underlying the Soledad Corona Estates subdivision. Four single-family residences were fully or partially destroyed during landsliding (5703, 5715 and 5725 Soledad Mountain Road and 5734 Desert View Drive Alley), while three other residences (5695 and 5735 Soledad Mountain Road and 5748 Desert View Drive Alley) sustained varying degrees of damage, but to date remain in place.

Mitigative measures were developed and implemented to address the local stability of the Soledad Mountain Road and Desert View Drive Alley Right-of-Ways with respect to the recent (October 3, 2007) landslide failure. Local stability for areas outside the limit of earthwork as shown on Plate 6 (Volume 4) is not addressed as part of this project. This report summarizes construction activities and presents as-built conditions, based on grading and construction plans developed by HGI completed in multiple phases between October 2007 and June 2009. Subsequent to construction, an aerial survey was performed of the as-built slope. The as-built topographical survey map of the project site, produced by the City of San Diego Survey Department and provided to HGI, was utilized as the base map for Plates 1, 5, 6 and 8 contained in Volume 4 of this report.

This portion of the stabilization included installation of 37 temporary shear pins along the headscarp of the landslide, installation of 38 permanent shear pins and a panel wall along the east side of the Soledad Mountain Road Right-of-Way, removal and replacement of landslide debris in Soledad Mountain Road, and reconstruction of road improvements.

2.0 SCOPE OF WORK

Our scope of work is limited to the geotechnical design, observation and testing and consulting services during stabilization of the portions of the City of San Diego Right-of-Ways affected by the October 3, 2007 landslide. Stabilization of private properties affected by recent landsliding is outside our scope of work and will require specific geotechnical investigations, conclusions and recommendations, for future improvements or redevelopment.

The following services were performed by HGI during and after grading and construction activities for the stabilization of the Soledad Mountain Road Right-of-Way:

- **Observation of Subsurface Conditions** – HGI observed the site soil conditions during drilling, excavation and grading to check subsurface conditions and soil properties interpolated from exploratory borings and test pits advanced as part of the preliminary subsurface investigations summarized in our reports entitled ***Preliminary Report of Geotechnical Features Soledad Mountain Road Landslide, 5700 Block Soledad Mountain Road, La Jolla, California***, dated December 28, 2007 and ***Geotechnical Design Report for Shear Pin Landslide Stabilization of Soledad Mountain Road Right of Way, 5700 Block Soledad Mountain Road, La Jolla, California***, (2 Volumes), dated March 13, 2008.

  Excavation monitoring was performed throughout the project to check that excavation limits conformed to those specified in the project plans, and that adequate embedment of fill soils below the landslide rupture surface was achieved. Cut slopes were mapped to document subsurface geologic conditions and to see that adversely dipping planes of weakness such as bedding plane shears, joint sets or faults were not present that would impact excavation stability.

- **Downhole Logging of Shear Pin Borings** – Selected shear pin borings were downhole logged by a Certified Engineering Geologist, Registered Geotechnical Engineer or Professional Geologist to check the depth and inclination of the landslide rupture surface, to document other planes of weakness (if present) as well as pertinent geologic features and to check adequate shear pin embedment into competent soils.

- **Monitoring of Shoring Installation** – Installation of shoring between cast-in-drilled-hole (CIDH) shear pins was monitored to check that shoring extended to the design depths and was grouted at the specified intervals, per the project plans.

- **Observation and Testing During Fill Placement** – Representatives of HGI documented the limits of removal and inspected and approved removal bottoms prior to placing fill or other improvements. Our representatives performed compaction testing during fill placement utilizing the Sand Cone Method (ASTM D-1556) and/or the Nuclear Densometer Method (ASTM D-2922), and monitored the installation of geogrid to check compliance with the project plans and manufacturer's specifications for proper installation.

- **Import Soils –** Import fill soils were approved by HGI prior to hauling. Gradation specifications and maximum dry density tests were performed in our laboratory.

- **Laboratory Testing –** Laboratory testing was performed throughout the project to check soil conditions and strength parameters for design purposes. Tests included maximum dry density, in-place moisture and moisture density, grain size analysis, direct and residual shear testing, consolidation, Atterberg Limits and chemical properties. Test results are summarized in Appendix M (Volume 3).

- **Review and Compilation of Test Results of Special Inspection of Concrete and Steel Reinforcement** – Results from special inspection of rebar reinforcement and concrete testing for CIDH shear pins were reviewed to check conformance with the project plans. Test results were compiled and are presented in Appendix E (Volume 3).

- **Construction Monitoring** – Construction monitoring, including monitoring of slope inclinometers, portable seismographs, crack gauges and survey monuments was performed throughout the project. Photographs were also taken of improvements to check distress features of existing improvements.

  Inclinometers were installed within the October 3, 2007 landslide mass, as well as in adjacent areas, to enable monitoring of subsurface movement, and to monitor temporary slopes during excavation and construction. Readings were performed weekly, or as-needed depending on construction activities. Post-construction monitoring of selected remaining inclinometers is ongoing and is performed on a quarterly basis. Inclinometer installations are shown on Plate 7 (Volume 4) and results are presented in Appendix I (Volume 3).

  Monitoring of ground vibrations was performed throughout the course of the project in order to check that construction related vibrations remained within tolerable limits with respect to adjacent residential structures. Portable seismographs were set up in a variety of locations on fixed or portable basis, depending on the specific location of construction activities on the site and the proximity to adjacent residential structures. Seismograph monitoring locations are shown on Plate 7 (Volume 4) and results are presented in Appendix H (Volume 3).

Crack gauges were installed across exterior cracks on 5735 Soledad Mountain Road due to the proximity of the residence to the northern side scarp of the October 3, 2007 landslide. Crack gauges were also installed and monitored at 5695 Soledad Mountain Road at the south flank of the landslide. Gauges were monitored and photographed periodically for comparison with previous readings.

A network of survey monuments was set up in and around the project site read by the City of San Diego Survey Department. Monitoring locations and frequency was determined by the City of San Diego. At the request of HGI, specific survey monuments and/or target reflectors were installed on residential structures in close proximity to the repair and read by the City of San Diego Survey Department as part of their monitoring program.

- **Geotechnical Consultation** – Geotechnical consultation, including attendance at weekly construction meetings was provided for the duration of construction.

- **As-Built Analyses** – Geologic conditions observed within the excavation limits and relevant to the subject repair in Soledad Mountain Road did not vary significantly from those identified during subsurface investigation. The majority of the landslide rupture surface was removed from the repair excavation and replaced with compacted select, reinforced fill soil. Accordingly, as-built analysis of stability is not considered necessary for the Soledad Mountain Road Right-of-Way Repair. Finite element analyses have been performed, based upon as-built conditions at the site, to estimate post-construction deflections that may affect improvements within the right-of-way. Finite element analyses are discussed in Section 7.0 and are presented in Appendix J (Volume 3) of this report.

- **As-Built Report** – The following report (Four Volumes), in addition to as-built plans for all phases of construction (Appendix C, Volume 3) have been prepared which outline construction details and the results of our observations, testing, and analyses.

3.0 SUMMARY OF GEOTECHNICAL INVESTIGATION AND ANALYSIS

At the request of the City of San Diego, HGI began a geotechnical investigation on October 2, 2007 to examine surface features that were developing within the 5700 Block of Soledad Mountain Road and Desert View Drive Alley. Following landsliding, which occurred on the morning of October 3, 2007 which rendered Soledad Mountain Road and the south end of Desert View Drive Alley Right-of-Ways impassable, HGI modified the scope of work to develop a plan for repair and stabilization. Preliminary conclusions and recommendations were issued in a pair of reports entitled ***Preliminary Report of Geotechnical Features Soledad Mountain Road Landslide, 5700 Block Soledad Mountain Road, La Jolla, California,*** dated December 28, 2007, and ***Conceptual Repair Options for Soledad Mountain Road and Desert View Drive Alley, Soledad Mountain Road Landslide, La Jolla, California***, dated February 11, 2008. Several repair options were considered, including tie-backs, shear pins, conventional earth buttresses and combinations thereof. However, in order to significantly reduce the potential for further lateral slope movement, and to provide increased slope stability during repair efforts with minimal encroachment onto private property, CIDH rebar reinforced concrete shear pins were selected as the preferred repair design alternative.

Field exploration following landsliding included geologic mapping of surface features and exposures, drilling and logging of small and large diameter borings and excavation and mapping of backhoe trenches within and adjacent to the landslide mass. A series of inclinometers were installed to monitor ongoing slope movement. Crack gauges were also installed on the exterior of certain adjacent residential structures to monitor any damage related to extension of side scarps. The results of these preliminary investigations were presented in our ***Geotechnical Design Report for Shear Pin Landslide Stabilization of Soledad Mountain Road Right of Way***, ***5700 Block Soledad Mountain Road, La Jolla, California***, (Two Volumes), dated March 13, 2008, which outlined the proposed repair design for Soledad Mountain Road.

Geologic documentation was performed throughout construction and included detailed field mapping of excavation exposures, additional small diameter borings performed for supplemental inclinometer installations, and downhole logging of selected shear pin borings. Appendix B (Volume 3) includes updated boring logs which have been revised to reflect additional data gathered during construction. Data gathered from downhole logging of shear pin borings is summarized in Appendix G (Volume 3).

4.0 CONSTRUCTION ACTIVITIES, GEOTECHNICAL OBSERVATIONS AND TESTING

4.1 Overview

Reconstruction of the Soledad Mountain Road Right-of-Way was performed by Hazard Construction, Inc., during the period of October 2007 through October 2008 (note that the eastern edge of the right-of-way was not completed until June 17, 2009). Anderson Drilling, Inc. and Marco Crane, Inc. were subcontracted by Hazard Construction, Inc. to construct the CIDH shear pins. HGI provided soils observation and testing on a continuous basis during construction.

Slope stabilization and repair of the Soledad Mountain Road Right-of-Way included installation of 75 CIDH rebar reinforced concrete shear pins, 42, 48 and 54, inches in diameter, installed in two phases. The initial phase of shoring installation occurred along the west and north sides of the landslide mass, and consisted of 37 CIDH shear pins, 42 and 48 inches in diameter. This phase of shoring was designed for two primary purposes: to prevent westward expansion of the headscarp, prevent further damage to private property and to allow eventual excavation of landslide debris which would be hindered by existing shear surfaces. The second phase of shoring was installed along the east side of the Soledad Mountain Road Right-of-Way, and consisted of 38 CIDH shear pins, 54 inches in diameter. The purpose of this phase of shoring was to provide long-term slope stability of Soledad Mountain Road, to provide safe working conditions during removal and replacement of landslide debris and to support the temporary grade separation that existed between finished grade on the restored right-of-way and the ungraded private lots to the west which had dropped approximately 16 feet during landsliding.

Following shear pin installation, landslide debris in the Soledad Mountain Road Right-of-Way was removed during a three slot phased construction process, and replaced with compacted, engineered fill consisting of geogrid reinforced Caltrans Class II aggregate base. Subsurface drainage was also installed to provide keyway drainage. Six-inch perforated, Schedule 40 PVC pipe surrounded by 3/4-inch washed rock wrapped in filter fabric was tied into a solid, fuse welded eight-inch HDPE outlet pipe installed and grouted in a sub-horizontal boring. The subdrain outlet was discharged through the east side of the excavation towards Desert View Drive Alley. The curb line, grade and finished road grades were restored to their pre-failure configuration.

4.2 Project Plans

Recommendations for repair were incorporated into a series of design plans prepared by HGI. Table 1 below summarizes final plan sets and plan changes that were signed by the City of San Diego and used for construction.

Table 1
Summary of Construction Plan Sets

Set Number	Title of Construction Plan Set	Work Order Number	Date Signed by City of San Diego	Sheet Numbers
1	Construction Plans For: Soledad Mountain Road Emergency Repair (Temporary Shoring)	992019	11/1/07	34701-01-D to 34701-03-D
2	Construction Plans For: Soledad Mountain Road Emergency Repair (East Side Shoring)	992019	3/18/08	34701-01-D to 34701-03-D
3	Grading Plans For: Soledad Mountain Road Emergency Repair	992019	5/21/08	34701-01-D to 34701-11-D *Delta 1: Sheet 12 to Sheet 14 *Delta 2: Sheet 15 *Delta 3: Sheet 16
4	Construction and Grading Plans For: Desert View Drive Alley Emergency Repair	528051	10/20/08	34701-01-D to 34701-20-D *Delta 1: Sheet 21 to Sheet 22 *Delta 2: Sheet 23 *Delta 3: Sheet 24

*Additional sheets were added in the field to the plan set maintained by the City of San Diego Resident Engineer.

Reports, plans and delta revisions prepared by HGI for the project are also listed in Appendix A (Volume 3). Due to the emergency nature of the project, newly issued mylar plan sets and delta plan changes (issued on separate sheets) were signed in the field by the City of San Diego, thus preventing any breaks in the construction schedule. Plan sets 2 through 4 (as listed above), along with sewer and water utility restoration plans (prepared by the City of San Diego) were combined into a single as-built plan set comprising 50 sheets. A copy of the final as-built set is presented in Appendix C (Volume 3).

4.3 Construction Sequencing

The following is a detailed discussion of the sequence of construction events for the repair and reopening of the Soledad Mountain Road Right-of-Way:

4.3.1 Installation of Temporary Shoring (Shear Pins 1 through 37) – A series of 37 CIDH shear pins, 42 and 48 inches in diameter were installed along the west side of the Soledad Mountain Road Right-of-Way. Shear Pins 1 through 23 were 42 inches in diameter, installed eight feet on center, while Shear Pins 24 through 37 were installed seven feet on center.

The minimum design strength for concrete was 5000 psi. All concrete was placed by the tremie method and a concrete vibrator was used in the upper ten feet. Data gathered during installation of shear pins, including construction dates, depths and elevations are tabulated in Appendix G (Volume 3). As-built locations are shown in Figure G-1 (Appendix G, Volume 3). Drilling and concrete placement sequence was staggered per specifications on the project plans to prevent open adjacent borings that may have resulted in caving or disruption of fresh concrete. To maintain reasonable production rates and achieve the required sequencing, two drill rigs were used concurrently for shear pin drilling. Inclinometers were installed in Shear Pins 16 and 29 for monitoring during excavation and removal of landslide debris. Both were later abandoned and buried during the repair of the roadway. The two abandoned casings were encapsulated in concrete from shear pin construction.

North to south drainage along Soledad Mountain Road was maintained during shear pin installation along the west side of the road by means of temporary sand bags, asphalt berms and a temporary pipe used to channel water along the alignment of the curb and gutter destroyed by the landslide. Shear Pins 1 through 37 were completed on December 13, 2007.

4.3.2 Demolition and Winterization – During December 2007, residential structures at 5703, 5715, and 5725 Soledad Mountain Road were razed. Prior to demolition, residents were provided access to their homes to remove personal property. Removal of personal belongings was facilitated by crane-placed cargo containers at the front of the residences where wheeled vehicle access was not feasible due to the disruption of the street.

Once the landslide area was stripped of surface improvements, building foundations and landscaping (debris was disposed of off site), surficial grading was performed in accordance with draft winterization plans. The head of the landslide was graded to construct a temporary desilting basin within the Soledad Mountain Road Right-of-Way. Drainage was directed to a slotted standpipe at the center which outletted via a buried, 12-inch, Schedule 40 PVC tightline to existing surface drainage improvements on Desert View Drive Alley at the toe of the landslide. The desilting basin was lined with plastic sheeting held in place with sand bags. A semi-permanent asphalt drainage channel was also constructed in the alignment of the previously destroyed curb and gutter along the west side of Soledad Mountain Road.

Other grading during the winterization process included reconfiguring the descending slope between Soledad Mountain Road and Desert View Drive Alley to a 3:1 (horizontal to vertical) inclination to improve temporary stability of the slide mass and adding fill in Desert View Drive Alley to buttress the toe of the landslide. Surface rolling of the slope face was performed to seal fissures and reduce erosion. Contouring of fill placed at the toe of the landslide also afforded limited vehicular access to homeowners south of the landslide toe which had not previously been possible. Temporary drainage measures were also installed at the toe of the landslide to re-establish drainage along existing curb and gutters that had been buried.

4.3.3 Installation of East Side Shoring (Shear Pins 38 through 76) – Shear Pins 38 through 76 are 54 inches in diameter, installed at 8.5 feet on center, along the northeastern edge of the Soledad Mountain Road Right-of-Way (Figure G-1, Appendix G, Volume 3). Installation data is tabulated in Appendix G (Volume 3). Note that Shear Pin 47 was not installed due to overlap with Shear Pin 37, which had previously been installed. The minimum required compressive strength for concrete was 6000 psi. Shear Pins 51 through 69 required two separate pours per shear pin to reach the required "top-of-concrete" grade, due to the drop in surface elevation across the landslide mass. A Sonatube form was cut to the required length and placed over the exposed steel reinforcement from the ground surface to the proposed top of pier for the second pour. The shear pins were installed with top-of-concrete elevations approximately four feet below the required finished grade within the right-of-way, to accommodate future installation of subsurface utilities. Slope inclinometer casings were installed inside Shear Pins 44, 56 and 63 for monitoring during excavation and grading.

Following installation, Shear Pins 49 through 70 were connected by poured-in-place concrete panels. The top of the panel wall was formed to match the adjacent piers, while the bottom of the panels matched existing grade at the time of construction. The concrete panels were 12 inches thick, reinforced with rebar per plan sheet 3 of 50 (Appendix C, Volume 3). The as-built panel wall is shown on Cross-Section AB 5-5‘(Plate 3, Volume 4). The purpose of the panel wall was to retain fill soils during restoration of the right-of-way until fill could be placed on the east side of the shear pins to eliminate the grade break. Sleeves were provided through panels between Shear Pins 55 and 56 and Shear Pins 62 and 63 to facilitate future installation of residential sewer connections for 5715 and 5703 Soledad Mountain Road, respectively.

4.3.4 Observation of CIDH Shear Pin Construction – Representatives of HGI were present on a continuous basis during the drilling and construction of CIDH shear pins. Borings were inspected for evidence of seepage, groundwater and caving. Reinforcement cage placement was documented to check that the cages were set at the correct depth relative to the landslide rupture surface. Although HGI was present during concrete placement, special inspection of reinforced concrete was performed by others under the direction of the City of San Diego Resident Engineer. Compressive strength test results as well as data gathered during CIDH shear pin installation are summarized in Appendix E and G, respectively (Volume 3).

Selected borings were downhole logged by a Certified Engineering Geologist, Professional Geologist or Registered Geotechnical Engineer to check that subsurface conditions conformed to those derived from earlier geotechnical investigations for design purposes. Although the primary purpose was to check the depth and attitude of the recent landslide failure plane, other planes of weakness, well developed joints and/or significant faults were also noted. Results of shear pin logging, combined with geologic mapping of the main excavation, were used to develop and refine the as-built geologic map, cross sections and landslide rupture surface structure contour map (Plates 1 through 3, and 5; Volume 4).

4.3.5 Excavation – Slot cut grading within the Soledad Mountain Road Right-of-Way was performed using conventional earthmoving equipment, including a Komatsu tracked excavator, Caterpillar D-5 and D-6 bull dozers as well as other equipment. Excavations were constantly monitored by our field representatives to check conformance with the project plans (Table 1) and specifications and to monitor excavation stability and safety. Geologic mapping and documentation was also performed daily to gather additional data on the landslide failure plane as well as other planes of weakness that may have impacted excavation activities. Plates 1, 2 and 3 (Volume 4) show the as-built geologic conditions for the site. Keyway bottoms were inspected, documented and approved prior to placement of fill soils. As-built subdrain line and grade was also documented by HGI. As-built keyway limits and subdrain alignment and invert elevations were also surveyed by the City of San Diego when a survey crew was available.

4.3.6 Slot Cut Grading – Following installation of CIDH Shear Pins 1 through 76, and immediately prior to commencement of full scale excavation and shoring activities, remaining buried utilities within the Soledad Mountain Road Right-of-Way, such as portions of the water and sewer lines, were carefully exposed, documented and removed from the site for further forensic evaluation under the direction of the City of San Diego forensic consultant, Ninyo and Moore, Inc.

As specified on the approved grading plans dated May 21, 2008 (Appendix C, Volume 3), complete removal of recent landslide debris was performed using slot cut construction methods. Prior to the excavation of Slot 1, grade across the entire excavation area was lowered to approximately 460 feet (msl), to create a more stable excavation. Slot cut grading, in three approximately equal length slots, was utilized in order to minimize loads on the west side shoring and to enable rapid filling in the event of loss of excavation stability during grading. As each slot was excavated, pressure treated timber lagging was installed between piers according to the project plans, to prevent raveling or failure of soil between piers. The void space behind the timber was grouted at intervals not exceeding 4 vertical feet. Excavations were continuously mapped and documented by representatives of HGI. Excavations were inspected daily and relevant inclinometers were read frequently to monitor excavation stability.

The first slot (Slot 1) was excavated on the north side of the landslide head scarp. Excavated materials were hauled off site to either Fiesta Island in Mission Bay (for later re-use) or to the Miramar landfill. Once the excavation had reached the specified elevation on the north and west sides, shoring was stopped and a 1:1 (horizontal to vertical) cut slope was constructed to the heal of the keyway. The contractor elected to bench the cut slope during excavation, rather than during fill placement, since excavated soils were not permitted for use as engineered backfill. On the east side of the excavation, shoring timbers were installed to a depth between three and six feet from the required elevation at the toe of the keyway bottom. The remaining excavation was cut at a 1:1 slope (horizontal to vertical) to the required elevation.

Following approval of the keyway bottom by HGI, keyway subdrains were installed. Subdrains consisted of six-inch diameter, Schedule 40, perforated PVC pipe surrounded by approximately 4.5 cubic feet per lineal foot of 3/4-inch washed gravel wrapped with Mirafi 140N filter cloth. The line and grade of the subdrain was field mapped and surveyed prior to fill placement. The as-built alignment is illustrated on the Plate 6 (Volume 4). Caltrans Class II aggregate base was used as fill for each slot. A 2:1 (horizontal to vertical) south-facing, false slope was constructed during placement of fill in Slot 1 to prevent mixing with onsite soils from adjacent slots and to maintain safe excavation conditions once the bottom of Slot 2 was reached. Primary geogrid reinforcement consisting of Miragrid 10XT was placed in accordance with the project plans at every 1.5 feet (vertical), to a maximum elevation of 467.5 feet (msl). In order to achieve the required compaction along the east side of the excavation (adjacent to Shear Pins 48 through 70), removable, four-foot high (approximately) form boards, constructed from 3/4-inch plywood, were placed between adjacent piers, to provide a solid surface to compact against. Once the fill had reached the elevation of the top of the form, the forms were pulled and reinstalled at a higher elevation. In order to prevent raveling of fill materials into the void created between adjacent shear pins, the timber lagging and the plywood form board, the fill was wrapped along the east side of the excavation using a secondary geofabric consisting of Mirafi HP570. A minimum of three feet of embedment top and bottom for the secondary geogrid was required. A minimum six inches overlap between adjacent sheets of both primary and secondary geogrid/fabric was also maintained. Voids were left between the edge of the reinforced earth and the span between shear pins until the Miragrid 10XT was brought to its highest design elevation. This was done to allow some stretch of the geogrid to develop tensile strength. After completion of placement of Miragrid 10XT, the voids were filled with 3/4-inch gravel. Mirafi HP570 was placed at one-foot intervals between elevations 468.5 feet and 471.5 feet (msl) per the project plans. Fill placement in Slot 1 was terminated at elevation 460 feet (msl), before excavation of Slot 2 began.

Slot 2 was constructed using the same procedure as outlined for Slot 1 above, with the exception of drilling the outlet for the keyway subdrain between Shear Pins 60 and 61. A small diameter, track-mounted, horizontal drill rig (Ditch Witch JT 3020) was initially used to drill the boring for the subdrain outlet structure. Difficult drilling conditions required the use of a larger rig to complete the boring (Ditch Witch JT 7020). In order to obtain a minimum fall of 2%, HGI provided a supplemental detail showing the required alignment and daylight location in the slope above Desert View Drive Alley to the east. Construction staking for the alignment was provided by the City of San Diego. A handheld magnetic locating device was used by the driller for the purposes of maintaining alignment along the property line between 5703 and 5715 Soledad Mountain Road. The as-built fall for the outlet was approximately 2.1%. An eight-inch diameter HDPE pipe was pushed uphill, through the sub-horizontal boring, by the drill rig in 20-foot sections. Adjoining sections were fused together until the inlet point for the keyway subdrain at the base of Slot 2 was reached. The subdrain in the keyway was connected to the HDPE pipe by means of a short section of six-inch, Schedule 40 PVC tightline which was threaded into the HDPE pipe. Note at the time of installation, it was thought that the required alignment had been achieved. HGI had relocated Shear Pins 104 through 108 (not yet constructed as part of the Desert View Drive Alley stabilization) based upon the contractor’s interpreted alignment of the outlet in order to avoid damage to the subdrain outlet. However, during drilling of Shear Pin 105, the HDPE subdrain outlet pipe was severed and the upslope potion of the line was pulled out of the boring sidewall and out of the hole, necessitating reconnection to the keyway subdrain under Soledad Mountain Road. The reconnection was completed on May 7, 2009. Further discussion of this issue is provided in Volume 2 of this report.

Following approval of the keyway bottom and completion of the subdrain outlet, geogrid-reinforced fill was placed, tying back into the south facing false slope constructed during grading in Slot 1. Another south-facing false slope was created during filling of Slot 2 along the Slot 2/3 boundary. Fill in Slot 2 was terminated at elevation 460 feet (msl) to match Slot 1.

Slot 3 was excavated and filled per Slots 1 and 2. Additional care was taken to remove temporary fills that had been placed along the south side of the excavation to provide access for construction equipment. Fill production rates increased once the fill elevation in Slot 3 matched Slots 1 and 2 (elevation 460 feet, msl). Fill was brought up to an approximate elevation of 468 feet (msl), at which point a shallow trench was excavated along the required alignment for the new sewer line in Soledad Mountain Road. The original vitrified clay pipe sewer, which flowed south to north, was replaced with eight-inch HDPE flowing from north to south. Above elevation 467.5 feet (msl), Mirafi HP570 was used both along the east side of the excavation to wrap the fill adjacent to the shear pins, but also in layers every one-foot in elevation. At approximately five feet below finished subgrade, the limits of grading were expanded to the north and south of the original landslide limits, in order to minimize the effects of differential settlement. Mirafi HP570 was also placed in the expanded fill areas to further reduce the potential for surficial cracking in the finished roadway due to the deep fill placed in Slots 1 through 3. Limits of expanded fill areas are shown on Plates 6 and 8 (Volume 4). Figures 2A through 2C illustrate the aforementioned slot-cut sequence. As-built geologic conditions are depicted on Plates 1 through 3 (Volume 4).
Installation of Mirafi 10XT (Primary Geogrid) and Mirafi HP570 (Secondary Geofabric) was closely monitored by representatives of HGI to check placement, overlap and embedment. Care was taken to make sure sheets were staked down prior to placement of fill. Creased, wrinkled or displaced sheets as a result of fill placement or equipment traffic were re-laid. Damaged or improperly cut sheets were replaced.

4.3.7 Finish Grading and Paving – As previously discussed, finish grading performed in the upper five feet (below finished subgrade) was expanded beyond the limits of the original landslide footprint to include an additional 20 feet (approximately) to the north and south. Along the east edge of the Soledad Mountain Road Right-of-Way, where a grade separation of approximately 16 feet now existed across the CIDH shear pins (Shear Pin 50 through 70) a 30-foot horizontal set back between the east edge of the CIDH shear pins and the finished subgrade below Soledad Mountain Road was maintained with the resulting four-foot (approximate) grade separation bridged by a 1.5:1 (horizontal to vertical) false slope (See sheet 19 of 50, Appendix C, Volume 3). Shallow utilities, such as gas and water lines for future redevelopment of razed lots were installed in the upper five feet of fill and capped off in the 1.5:1 false slope along the east edge of the road. Chain link construction fencing, k-rails and temporary road striping were installed to keep traffic and pedestrians away from accessing the east side of the road.

Initial repaving of the main portion of the Soledad Mountain Road Right-of-Way was completed on October 14, 2008. Final repaving of the eastern edge of the right-of-way (completed after the repair of Desert View Drive Alley) was completed on June 17, 2009. The upper 12 inches of Caltrans Class II aggregate base was compacted to a minimum of 95% relative compaction (ASTM D-1557), per the project plans and specifications.

Fine grading of landscaped areas, irrigation installation and concrete flatwork required to restore residential properties on the west side of Soledad Mountain Road damaged during landsliding or during grading and construction, were performed by Valley Crest, Inc., in accordance with City of San Diego requirements and plans prepared by others. This work was not inspected by HGI. Valley Crest, Inc. was also responsible for the implementation of erosion control measures.

4.3.8 Fill Placement and Compaction – Artificial fills were placed in accordance with the project plans (Table 1) and specifications. HGI performed monitoring and testing of compacted fills and geogrid installation. Fill was tested using either the Sand Cone Method (ASTM D-1556) or the Nuclear Densometer Method (ASTM D-2922) to demonstrate a minimum of 90% relative compaction (ASTM D-1557). Fill soils compacted to less than 90% relative compaction were subjected to additional compaction effort, or scarified and re-compacted until test results indicated 90% relative compaction was achieved. Field density tests are summarized in Appendix F (Volume 3). Density test locations are illustrated on Plate 6 (Volume 4).

The upper 12 inches of subgrade/base soils under Soledad Mountain Road were moisture conditioned and compacted to at least 95% relative compaction (ASTM D-1557). Subgrade soils underneath sidewalk areas were compacted to 90% relative compaction (ASTM D-1557). Subgrade density test results are summarized in Appendix F (Volume 3). Asphaltic concrete was placed and compacted under the observation and testing of City of San Diego inspectors, and was not part of HGI's scope of work.

5.0 MONITORING AND INSTRUMENTATION

In order to monitor the stability of temporary open excavations and areas adjacent to the construction site, and to monitor the effects of construction equipment on surrounding structures, a construction monitoring program was implemented throughout the duration of construction activities. This program included the use of slope inclinometers, portable seismographs, crack gauges, settlement monuments and survey target reflectors. A map showing inclinometer installations and setup locations for the portable seismographs is provided as Plate 7 (Volume 4). Settlement monuments and survey target reflectors were utilized in the repair of Desert View Drive Alley and are discussed in Volume 2 of this report.

5.1 Slope Inclinometers

During construction, excavation stability, and stability of other adjacent slopes were monitored by a series of frequently read inclinometer installations. Inclinometer installations are shown on Plate 7 (Volume 4). Inclinometers were installed in either small diameter borings (14 total) or inside the reinforcement cages of shear pins (ten total). All installations were constructed using 2.75 OD quick-connect, non-perforated inclinometer casing manufactured by Durham-Geo/Slope Indicator (SINCO). Casings installed in small diameter borings were grouted in place using the standard 3:1 cement/bentonite mix ratio for medium to hard soils as specified by SINCO. Inclinometer installations in small diameter borings were permitted by the County of San Diego, Department of Environmental Health under permit numbers LMON 105200, LMON 106088 and LMON 106332.

As illustrated on Plate 7 (Volume 4), ten installations (SP-27, SI-1, SI-2, SI-3, SI-5, SI-6, SI-9, SI-10, SI-11 and SI-14) have been destroyed. These installations were either removed during construction, or (in small diameter borings) abandoned using destruction methods approved by the County of San Diego, Department of Environmental Health.

Inclinometers were read as necessitated by construction activities. Pertinent installations close to open excavations were read daily or weekly depending on the level of construction activities, the depth of excavation and/or the level of fill placement. Installations further away from areas of construction were read less frequently. Appendix I (Volume 3) contains a table summarizing the inclinometer installations at the site as well as data plots from each installation. Note that the inclinometer plots show representative reading dates that span the entire length of monitoring, with some interim monitoring dates omitted for clarity.

5.2 Vibration Monitoring

Two Instantel "Blastmate III" portable seismographs were set up at various locations to monitor ground vibration during construction (Plate 7, Volume 4). The purpose of the vibration monitoring was to detect vibrations specifically related to construction activity near residential properties that exceeded a threshold level. Monitoring locations included fixed setups immediately adjacent to a specific construction activity (i.e. shear pin drilling close to a residential structure, or near haul routes) or portable setups. Fixed setups were secured in locked boxes to gather continuous monitoring data.

A total of 64 geophone locations were utilized (Plate 7, Volume 4). For temporary setups, the geophone was oriented directly towards the construction activity, in between the potential source of vibration (i.e. construction equipment) and the nearest residential structure. Locations were most commonly adjacent to the foundations for the residences surrounding the landslide repair, although monitoring along outlying residences was also periodically performed to monitor the effects of construction traffic to and from the site. Potential sources of construction vibration included, but was not limited to: 1) drilling of large and small diameter borings, 2) grading activities 3) CIDH shear pin construction, 4) setup, use, and breakdown of the large, mobile cranes used for placement of the steel reinforcement for shear pins, 5) assorted construction operations including heavy truck traffic, excavators, and other construction equipment utilized during the process of removal of debris, and delivery of construction materials to and from the site, 6) fill compaction, and 7) street paving.

The Instantel "Blastmate III" records several variables, including Peak Particle Velocity (PPV) and vibration frequency, which can be used to evaluate the effects of vibrations generated by construction activities on residential structures. Low frequency vibrations have been found to be capable of causing damage at low PPV. As frequency of vibration increases, the PPV level required to cause structural damage also increases. The U.S. Bureau of Mines (USBM) has recognized a "Safe Limit Criteria" for vibrations based on PPV and frequency of vibration. A PPV of 0.2 inches per second represents the lower bound of the "Safe Limit Criteria" at a frequency as low as one Hz (one cycle per second). The seismographs at this site were set at this level, recording any vibration events that exceeded 0.2 inches per second PPV.

A summary table of the vibration monitoring activity is included in Appendix H (Volume 3). Events were recorded when the threshold of 0.2 inches per were exceeded. These generally consisted of records developed when heavy equipment, including drill rigs, bulldozers, excavators, and vibratory compaction equipment were operated in close proximity (five to ten feet) to the portable seismograph.

Note that out of the of the 370 trigger events outlined in Appendix H (Volume 3), only four, isolated events had PPV at frequencies which exceeded USBM limit criteria. In all cases, no evidence of damage to surrounding structures was observed during examinations performed following the completion of work.

5.3 Crack Gauges

Crack gauges were set up across cracks on residential structures located at 5695 and 5735 Soledad Mountain Road. Crack gauge locations are shown on Plate 7 (Volume 4). Crack gauges were documented photographically so that new readings could easily be compared with previous ones. No significant widening of cracks was observed during the repair of the Soledad Mountain Road Right-of-Way.

5.4 Post-Construction Monitoring

Several inclinometer installations remain in service to the date of this report, as shown on Plate 7 (Volume 4). In order to monitor the long-term performance of the landslide repair, as well as the immediate surrounding area, quarterly readings of remaining installations are anticipated to be performed for approximately one year.

6.0 GEOLOGIC CONDITIONS

6.1 Regional Geology

Regional geologic conditions in the Mount Soledad area of San Diego were discussed in detail in our ***Geotechnical Design Report for Shear Pin Landslide Stabilization of Soledad Mountain Road Right of Way***, ***5700 Block Soledad Mountain Road, La Jolla, California***, (Two Volumes), dated March 13, 2008. Geologic conditions documented at the site during investigation and construction generally conform to published geologic maps (Kennedy, 1975, 2008) which indicate that the site is underlain by the Ardath Shale (Ta), a sedimentary unit consisting of light brown to gray, interbedded, fine grained sandstones, siltstones, and claystones.

6.2 Site Geology

Geologic mapping at the site, specifically during mapping of keyways and backcuts, revealed a number of surficial geologic units, elements from original site development during the 1960's as well as localized structural discontinuities not visible on 1:24,000 scale regional geologic maps. The following section is an overview of geologic conditions at the site, based on field mapping performed by representatives of HGI.

6.2.1 Observed Geologic Units **–** The geologic units described below (with the exception of the Mt. Soledad Formation) are shown in plan view and cross section on Plates 1 through 3 and 8 (Volume 4), which depict the as-built geologic conditions at the site. Note that this volume of the report only discusses those units mapped or placed as fill within the limits of the Soledad Mountain Road repair. Geologic units on Plate 1 (Volume 4) are depicted in plan view as they were exposed at the maximum limits of excavation (i.e. in keyway backcut slopes or benches). Descriptions of the geologic map units are as follows:

- **Class II Aggregate Base (Qaf_b) –** Fill placed in Soledad Mountain Road consisted of Caltrans Class II aggregate. This material was imported to the site, moisture conditioned, and placed as compacted fill to a minimum 90% relative compaction (ASTM D-1557).

- **Artificial Fill-Older (Qaf) –** Previously placed artificial fill was encountered during preliminary investigations, and was mapped just below the existing grade at the southeast corner of excavation, in front of 5695 Soledad Mountain Road. This material consists of poor to moderately compacted sandy silts and clays with occasional, isolated subrounded gravel or cobbles. These fill soils were placed either during the initial rough grading of the site in the late 1950's, or during re-contouring of the 1961 landslide area, circa 1967.

- **Recent Landslide Debris (Qls_r) –** Created by landsliding on October 3, 2007, which involved a block-glide translation of a portion of a larger ancient landslide underlying the site. As observed during subsurface investigations and slot cut grading, this material generally consisted of light gray to light brown, interbedded siltstones, claystones and sandstones, derived from Ardath Shale. The materials were highly fractured. Recent landslide debris was removed with the limits of keyway excavation and grading per the requirements of project plans.

- **Colluvium (Qcol) –** Minor amounts of colluvial soils were mapped to the southeast of the excavation in the Soledad Mountain Road right-of-way between 5685 and 5695 Soledad Mountain Road (Plate 1, Volume 4). The colluvium consisted of dark brown silty to sandy clay, exposed in a continuous band of variable thickness underlying the existing artificial fill (Qaf). The mapped material was moderately stiff, slightly moist, and homogenous in color, without significant roots or organic content. The colluvium represents in place, or partially reworked soil material on which fill was placed during grading of the Corona Estates development.

- **Ancient Landslide (Qls_a) –** As previously discussed, a larger, ancient landslide complex underlies the site, comprised of moderately fractured siltstones and claystones (derived from Ardath Shale) that are inherently unstable and have been subject to downslope movement in the geologic past. Site development has altered the surface topography, coupled with normal weathering and erosion processes prior to development, have made the limits of the ancient slide complex difficult to discern. Interpretation of predevelopment aerial photographs and projection of a bedding plane shear outside the limits of work, suggest that it underlies residential construction surrounding the landslide repair area. Within the limits of excavation, the rupture surface of the ancient landslide was commonly five to eight feet below the October 3, 2007 landslide rupture surface and continuous around most of the excavation. The rupture surface was developed on a three to six inch thick seam of remolded blue gray clay. Landslide debris between the recent rupture surface and the ancient landslide surface was relatively intact. Consequently, the rupture surface could be interpreted as a bedding plane shear in the absence of geomorphic features suggestive of the larger ancient landslide.

- **Ardath Shale (Ta) –** The bedrock unit underlying the site is mapped as Ardath Shale. It was routinely exposed in the deeper boreholes and excavations. As observed, it consisted of poor to moderately bedded, weakly fissile, olive brown siltstone, interbedded with more massive light orange to yellow-brown siltstones and very fine grained sandstones. This material was relatively stiff and intact in contrast to the recent landslide debris. Zones of joints and minor faults were mapped within the unit, commonly trending north-northeast.

- **Mt. Soledad Formation (Tms) –** In two large diameter borings, AGLB-2 (by American Geotechnical) in Soledad Mountain Road and LD-4 in lower Desert View Drive, sharp contacts between the Ardath Shale and an underlying conglomerate from the Mt. Soledad Formation were encountered at approximate elevations of 382 feet (msl) and 298 feet (msl), respectively. The conglomerate portion of the Mt. Soledad Formation is polymictic and clast-supported (60% clasts, 40% matrix). Clasts were well rounded, one to eight inches in diameter and appeared not to be imbricated where exposed in the borings.

6.2.2 Excavation Conditions – Excavation conditions were documented by representatives of HGI. Excavation conditions are presented on Plate 1 (Volume 4). Geologic mapping, in profile, was not practical due to the placement of shoring between drilled piers, so geologic features and structural data were recorded in plan view (Plate 1, Volume 4) and transferred onto the as-built geologic cross sections (Plates 2 and 3, Volume 4). Selected photographs showing excavation conditions are presented on Figures 3A through 3H.

In general, the limits of excavation and keyway configuration were in accordance with the project plans. The keyway was founded in competent Ardath Shale, a minimum of two feet below the lower of the two sub-parallel sheared clay seams on the east side of the keyway.

Minor modifications to the excavation limits on the south end of the keyway were made for construction equipment access. Additional modifications to the excavation limits were made in the upper six feet (below finished grade) to accommodate geofabric placement slightly beyond the limits of the October 3, 2007 landslide.

6.3 Geologic Structure

The site lies near the crest of the Mount Soledad anticline, a broad, asymmetrical fold resulting from compressional forces that developed along a bend in the Rose Canyon Fault Zone (Figure 4). Mapping by Kennedy (1975) indicates that the axis of the anticline is not well defined in this area of La Jolla and that it may be truncated on the south by the Rose Canyon Fault Zone. Bedding attitudes shown on Kennedy’s map in the area of the site generally indicates low to moderate dips of 10 to 16 degrees to the east and southeast.

These attitudes are in agreement with geologic mapping performed by HGI during the investigation and repair of the Soledad Mountain Road Landslide. The predominant dip direction is to the east-northeast within the slide excavation, although localized variations and reversals were noted due to folding and faulting within the Ardath Shale bedrock. Mapped dips generally range from 5 to 30 degrees. Variations in dip direction and degree are most common in the upper stratigraphy, which has been disrupted by the ancient landsliding. Recorded strikes and dips of the rupture surfaces, bedding planes, joints and fault surfaces mapped during grading are plotted on the As-Built Geologic Map (Plate 1, Volume 4).

Plate 5 (Volume 4) shows the structure contour map for the landslide rupture surface of the October 3, 2007 landslide. It was constructed using attitudes recorded during downhole logging of large diameter borings and shear pin borings, as well as from exposures formed during keyway excavations. The surface is generally synclinal in shape, with an east-northeast plunging fold axis. Field mapping suggests that the rupture surface is wholly or partially truncated and offset along the northern margin of the landslide mass. A number of sub-parallel, slickensided, northeast-southwest striking shears or minor faults, with steep southeast oriented dips were noted during field mapping following the landslide. In addition, borings logged north of the landslide in Soledad Mountain Road, such as LD-2, AGLB-2, SP-34 and SP-44 contained abundant high angle shears with offsets up to several feet across them, making it very difficult to project the rupture surface to the north of recent landslide mass. Further evidence of offset in the landslide rupture surface was documented in the excavations for the repair of the Desert View Drive Alley Right-of-Way, which are discussed in detail in Volume 2 of this report.

Numerous other high angle shear zones were documented both in large diameter borings such as LD-1 (Appendix B, Volume 3), borings for CIDH shear pins and during the excavations, most notably in the vicinity of Shear Pin 9 through Shear Pin 13. In this area, numerous high angle shear surfaces with offsets up to two feet were noted (Plate 1, Volume 4). In general, high angle shear surfaces/faults were oriented in a northeast-southwest direction, typically showing less than 12 inches of normal offset dipping either southeast or northwest. No strong evidence was observed or mapped that supported the presence of the Country Club Fault on the site, although some high angle shearing was noted in the southern portion of the excavation (south of Slot 3) that was similar in location and orientation to the Country Club Fault shown on Kennedy's Map (1975, 2005).

6.4 Groundwater

The permanent groundwater table underlying Soledad Mountain is well below ground surface elevations at the site. In their geotechnical investigation of landsliding at lower Desert View Drive (1991), Leighton and Associates, Inc. indicated that no groundwater was encountered to their maximum depth explored of 181 feet. No groundwater table or significant perched water conditions were encountered within the recent landslide during the drilling performed for the investigation or repair, indicating that the groundwater table in the area of the recent landslide is likely more than 200 feet below the existing ground surface.

Minor seepage was observed in the upper portion of the excavation along the west side shoring, from three to eight feet below the ground surface. This seepage occurred following irrigation of the landscape areas on properties west and northwest of the landslide area. No free water was visible within landslide fractures or voids in the vicinity of the landslide rupture surface during removal.

6.5 Seismicity

The project site is located within a seismically active area (UBC Seismic Zone 4) and within the Rose Canyon Fault Zone. Historically, this area has been subjected to strong seismic ground shaking from major earthquakes, and it will continue to experience strong ground shaking in the future. An active fault is defined as fault that has experienced Holocene displacement (movement within the last 11,000 years). According to regional geologic literature, the closest known active fault is the northwest-southeast trending Mt. Soledad strand of the Rose Canyon Fault Zone, located approximately 300-500 feet northeast of the site. Several other active faults and numerous potentially-active and pre-Quaternary faults also are present within the vicinity. Figure 4 illustrates the proximity of the site to the Rose Canyon Fault Zone, a series of faults and associate folds aligned parallel to the drainage northeast of the site. The California Geological Survey has mapped the limit of the Alquist-Priolo Zone below lower Desert View Drive, approximately 350 feet northeast of the site. High angle shears and disrupted bedding were observed within the bedrock materials of the repair area, although no evidence of active faulting was apparent in exposures observed within the site excavation.

7.0 AS-BUILT ANALYSES

Geologic conditions observed within the excavation limits and relevant to the subject repair in Soledad Mountain Road did not vary significantly from those identified during subsurface investigation. The primary geometric constraints to design of the shear pins along the east edge of Soledad Mountain Road were the temporary and permanent grades during and after construction and the depth of the recent and ancient rupture surfaces. Sufficient data regarding these constraints had been acquired prior to the shear pin design. The majority of the landslide rupture surface was removed from the repair excavation and replaced with compacted select, reinforced fill soil. Accordingly, as-built stability analysis of the Soledad Mountain Road right of way in the repair area is not considered necessary as the repair was constructed as designed.

7.1 Finite Element Analysis

Analysis of post-construction deflection has been performed utilizing the Plaxis finite element program. For our estimation of post-construction deflections, we have assumed two conditions. The first condition is based upon existing slide debris and fill soils east of Soledad Mountain Road remaining in their current configuration. The second case assumes a temporary condition that may exist during future repair of the residential lots at 5703 to 5725 Soledad Mountain Road, namely removal of landslide debris east of the Soledad Mountain Road Right-of-Way. Deflection estimates are based on strength parameters issued in our report entitled ***Geotechnical Design Report for Shear Pin Landslide Stabilization of Soledad Mountain Road Right of Way, 5700 Block Soledad Mountain Road, La Jolla, California***, (Two Volumes), dated March 13, 2008, assumed modulus of elasticity values for compacted fill soils and landslide debris, published material properties for geogrid soil reinforcement and calculated stiffness properties for shear pins. Note that cohesion values for select fill were increased slightly for finite element analysis for calculation convergence purposes. Calculations for finite element analyses including detailed estimates of deflections are provided in Appendix J (Volume 3). Calculations were performed on typical cross section AB-3-AB-3’. Validity of calculated stiffness values for the shear pin system was checked with inclinometer data from Shear Pin SP-63 obtained during excavation of landslide debris in the right of way. The following estimates do not include long term creep effects. Calculated values for existing ground conditions may be exceeded by as much as 100 percent due to long-term creep.

Table 2
Estimated Post Construction Deflections at Ground Surface
East Side of Soledad Mountain Road Right of Way

File	Location/Condition	Horizontal Displacement* (inches)	Vertical Displacement* (inches)
SMR AB-3c As-Built	Soledad Mountain Road East Side of Right of Way -Top of Shear Pin – Existing Grades	0.25	0.50
SMR AB-3c As-Built	Soledad Mountain Road East Side of Right of Way -Approx. 5' West of Curb – Existing Grades	0.25	0.50
SMR AB-3c As-Built	Soledad Mountain Road East Side of Right of Way - Top of Shear Pin – Removal of Private Property Landslide Debris	5.0	1.25
SMR AB-3c As-Built	Soledad Mountain Road East Side of Right of Way -Approx. 5' West of Curb – Removal of Private Property Landslide Debris	2.5	1.25

*Values rounded up to nearest 0.25 inch.

8.0 CONCLUSIONS

The results of our field observations and testing during the repair of the Soledad Mountain Road Right-of-Way indicate that all elements of the repair including CIDH shear pins, subdrainage and engineered fill have been constructed in accordance with the recommendations of the project geotechnical report and plans. Variations from the approved project plans included three delta plan changes, Sheets 12 through 16 original construction plan numbering), and field changes due to actual conditions encountered during grading and construction. Field changes included modification of the excavation limits, subdrain alignment and extent of geogrid reinforcement. All field changes have been incorporated into the final, as-built plans (Appendix C, Volume 3).

Special inspection was performed throughout the repair in accordance with the requirements of the approved project plans. Special inspection results, summarized in Appendix E (Volume 3), indicate that all reinforced concrete for CIDH shear pins meets or exceeds the project specifications.

Results of construction monitoring (Appendices H and I, Volume 3) indicate that 1) excavations remained stable during construction, 2) deflections in CIDH shear pins are within acceptable limits and 3) that construction induced vibrations produced by heavy equipment operation did not cause or exacerbate damage to residential structures adjacent to the repair.

Geologic and geotechnical conditions encountered during construction were generally as described in our ***Geotechnical Design Report for Shear Pin Landslide Stabilization of Soledad Mountain Road Right of Way***, ***5700 Block Soledad Mountain Road, La Jolla, California***, (Two Volumes), dated March 13, 2008. Refinements to the geologic model are presented herein. No unusual geologic or geotechnical conditions were encountered during grading and construction that would adversely affect the performance of recently constructed improvements.

The Soledad Mountain Road Right-of-Way, within the limits of the October 3, 2007 landslide, has a calculated static factor of safety of at least 1.5 in its as-built condition and is considered suitable for vehicle and pedestrian use.

9.0 RECOMMENDATIONS

The following recommendations are provided by HGI, with respect to the completed repair of the Soledad Mountain Road Right-of-Way and adjacent private residences:

- **Slope Maintenance** – Property owners whose land is on or adjacent to the repaired October 3, 2007 landslide are responsible for slope maintenance on their respective properties. Slope areas on/or bordering the repair area should be periodically checked for erosion, areas of concentrated runoff, broken irrigation lines and other features that may affect the performance of the repair. Erosion gullies or areas of concentrated runoff should be repaired by redirecting drainage and/or by recontouring. Any significant disturbance to the slopes or broken water lines should be repaired immediately. Inspections should be performed at least annually and following significant rainfall episodes.

- **Drainage Maintenance** – The subject repair included restoration of private surface water drainage catchments on the Soledad Mountain Road properties. This included a concrete-lined brow ditch across the slope at 5735 to 5695 Soledad Mountain Road, an area drain pipe along the northwestern (side) yard of 5695 Soledad Mountain Road, a catch basin along the property line between 5695 and 5703 Soledad Mountain Road and a drain outlet onto Desert View Drive Alley below 5695 Soledad Mountain Road. Responsibility of maintenance of these drainage facilities lies with the respective property owners.

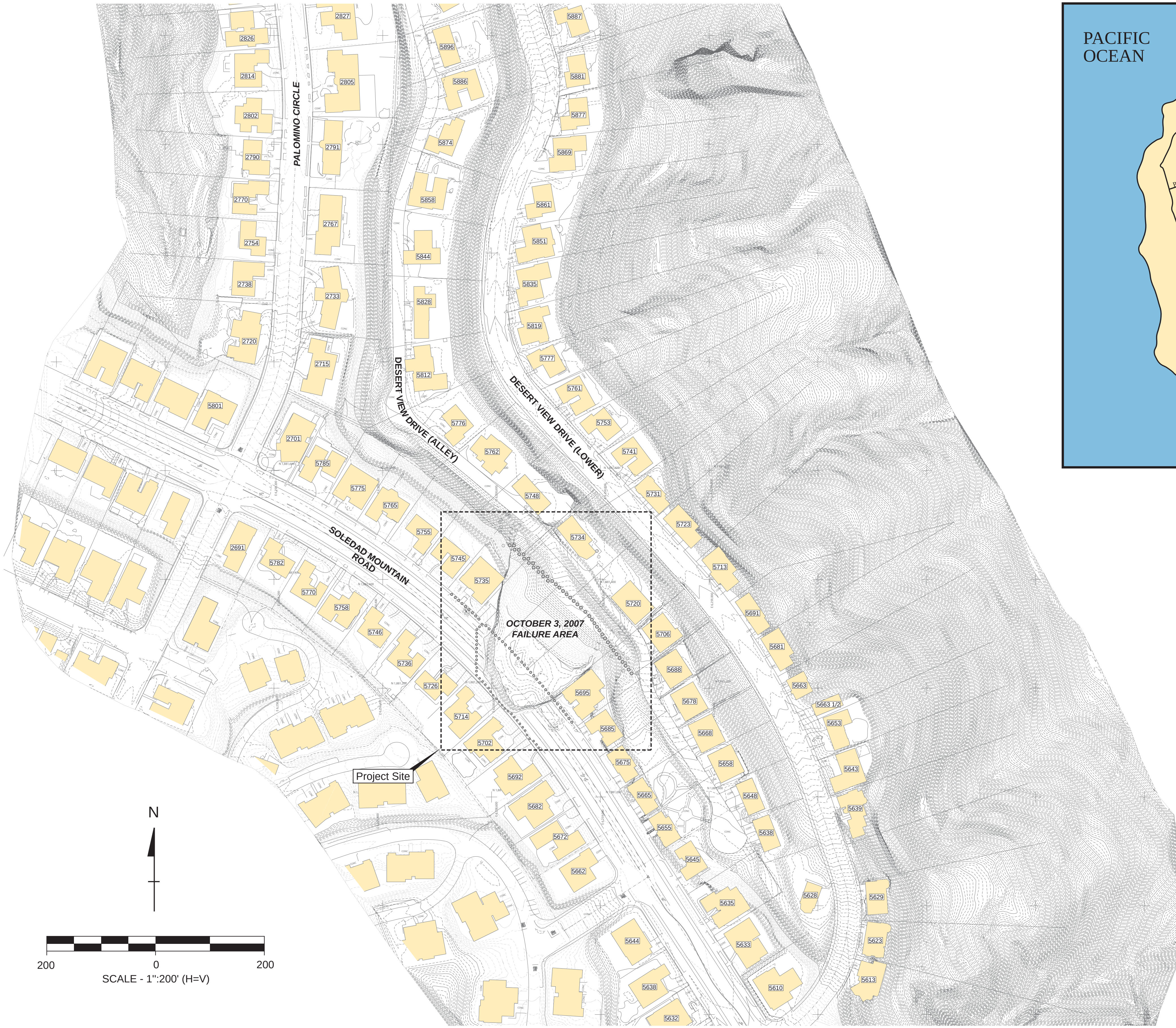
- **Inclinometers** – Continued inclinometer monitoring is recommended for the installations at the site for at least one year after. Long term monitoring needs or inclinometer abandonment procedures may be determined after a period of one year.

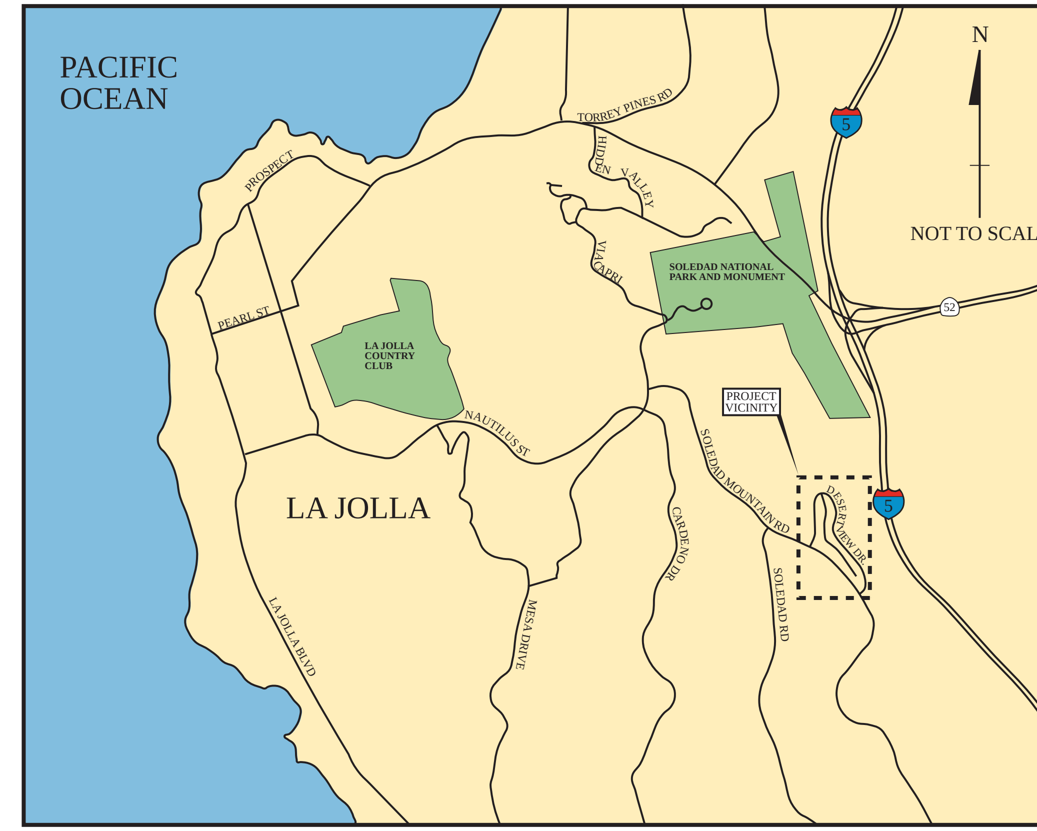
- **Re-development of Properties Affected by Landsliding** – The subject repair included restoration of site grades on the private properties directly impacted by the October 3, 2007 landslide: 5695, 5703, 5715, 5725, and 5735 Soledad Mountain Road as well as 5734 Desert View Drive. Our scope of work was not directed at stabilization of private properties for future development. Site-specific geotechnical investigations of these properties should be performed independently of the conclusions and results of the Soledad Mountain Road and Desert View Drive Alley stabilization activities presented herein. HGI assumes no responsibility for the use of geologic or geotechnical data developed during this project and used by others in conjunction with any private development or property use. Review and approval of future private property development is within the purview of the City of San Diego.

Redevelopment of private properties should include provisions for protection of the existing shear pin installations and improvements during construction. Excavation of landslide debris next to shear pins should be performed in an engineered sequence in order to limit the length and time of shear pin system exposure. Calculated deflections assume that excavations shall be kept dry and that constant geotechnical monitoring and analysis be performed during future stabilization efforts. We recommend that prior to approval of private property stabilization plans downslope of the shear pin system that Helenschmidt Geotechnical, Inc. be contracted to review potential impacts to the City Right of Way.

10.0 LIMITATIONS

Our services consist of professional opinions and recommendations made in accordance with generally accepted engineering geology and geotechnical engineering principles and practices. No warranty, express or implied, or merchantability of fitness, is made or intended in connection with our work, by the proposal for consulting or other services, or by the furnishing of oral or written reports or findings.



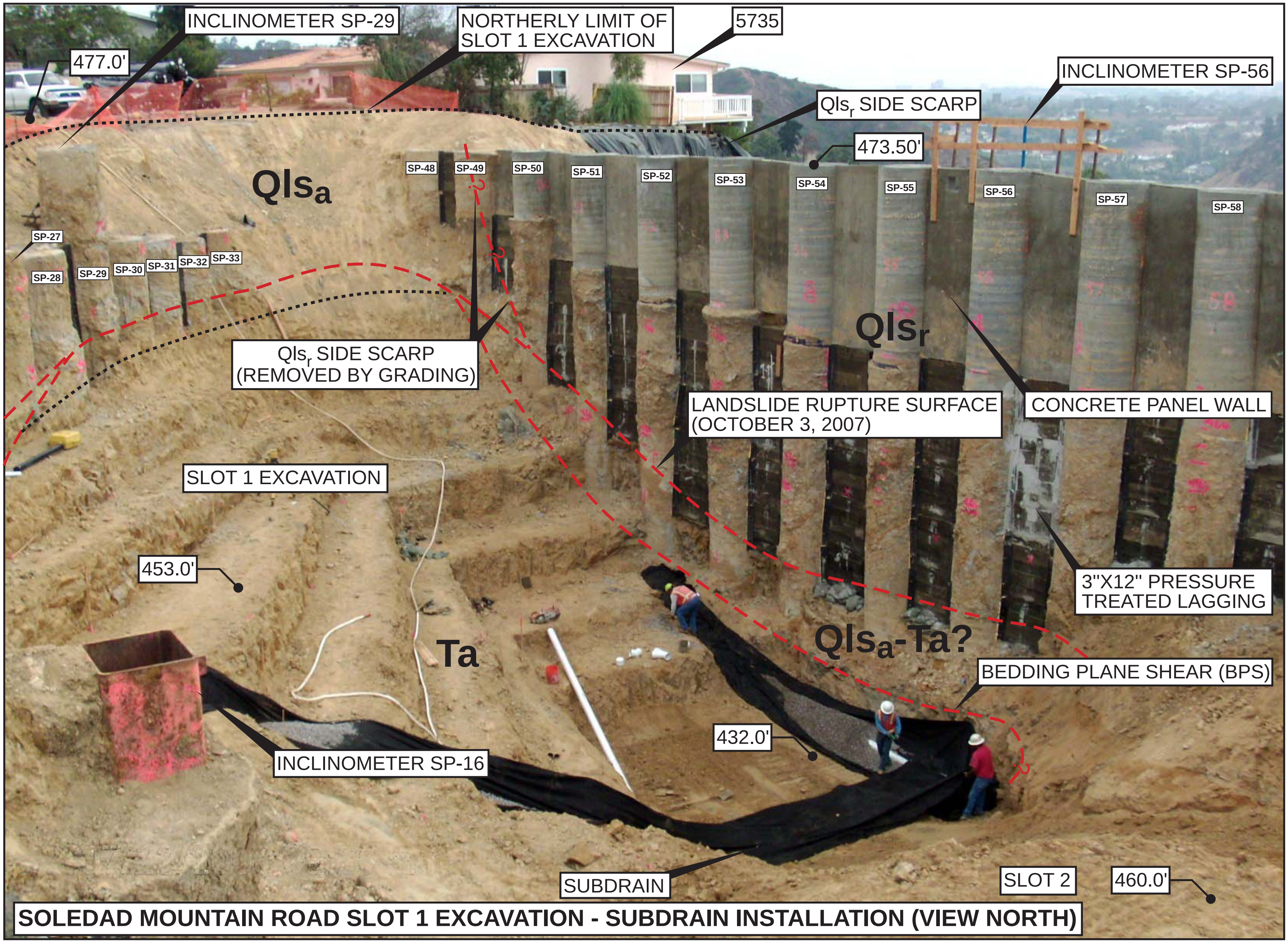


Helenschmidt Geotechnical, Inc.

Site Location Map

Soledad Mountain Road Landslide
La Jolla, California

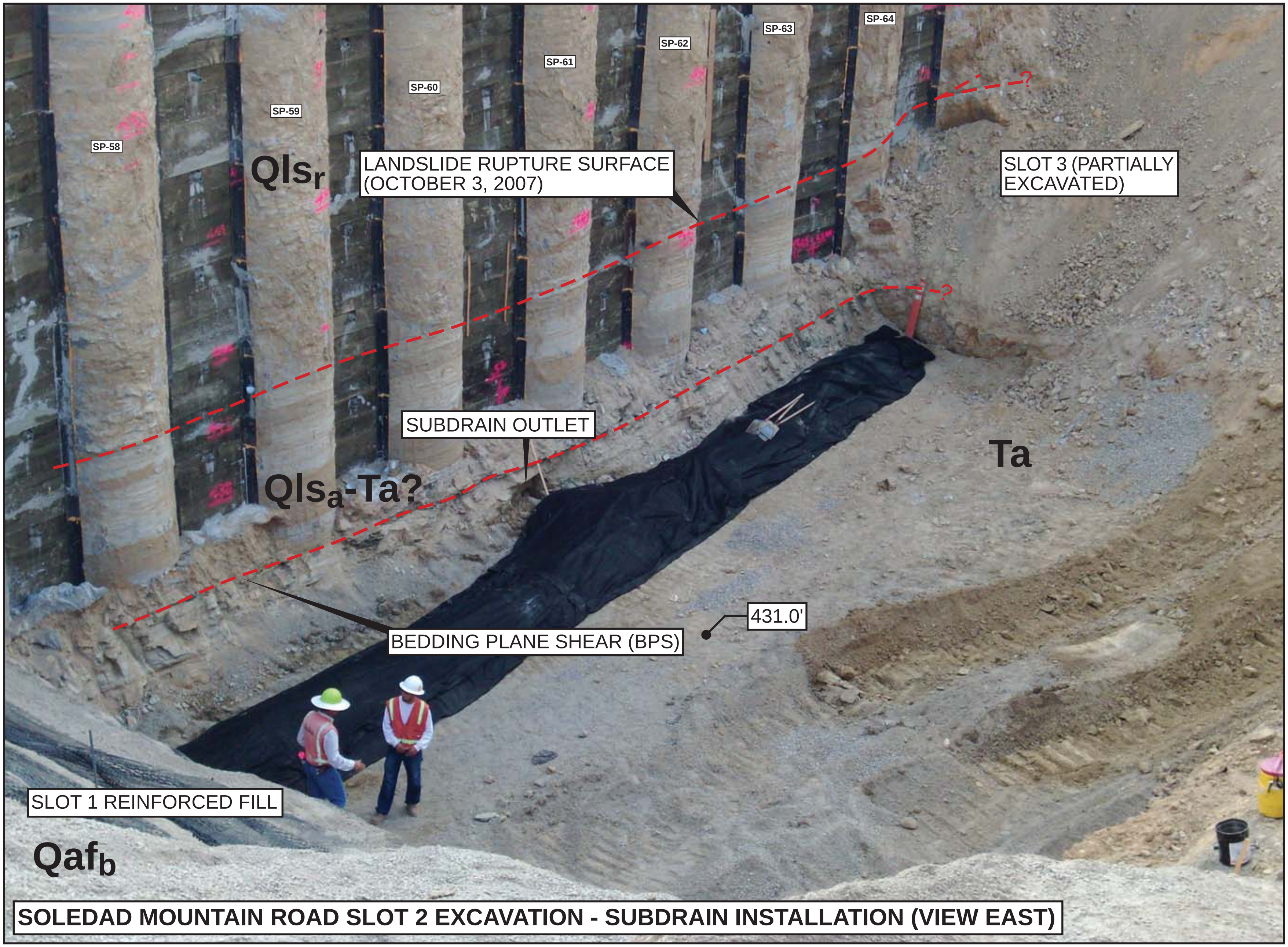
Project Number: 107069	Date: October 2010
Drafted: VN	Eng/Geo: SRH/RSA/MH
Scale: 1 Inch : 200 Feet	Figure Number: 1



SOLEDAD MOUNTAIN ROAD SLOT 1 EXCAVATION - SUBDRAIN INSTALLATION (VIEW NORTH)

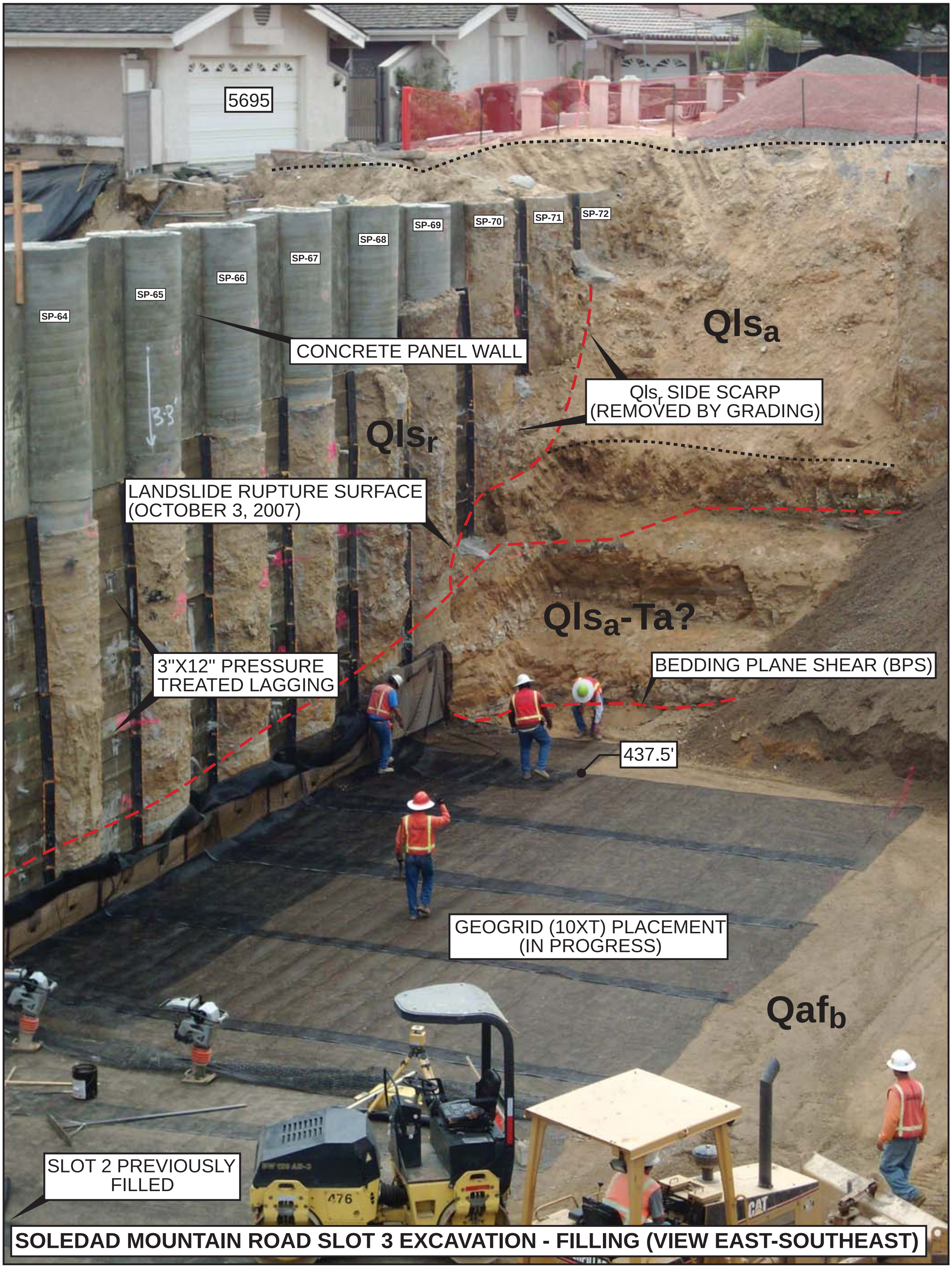
Helenschmidt Geotechnical, Inc.

FIGURE NUMBER: 2A PROJECT NO.: 107069



Helenschmidt Geotechnical, Inc.

FIGURE NUMBER: 2B PROJECT NO.: 107069



SOLEDAD MOUNTAIN ROAD SLOT 3 EXCAVATION - FILLING (VIEW EAST-SOUTHEAST)

INSTALLATION OF TEMPORARY SHORING ALONG WEST SIDE OF SOLEDAD MOUNTAIN ROAD SOUTH OF LANDSLIDE MASS

DRILLING OF EAST SIDE SHORING SOUTH OF LANDSLIDE MASS

Helenschmidt Geotechnical, Inc.

Construction Photos

Soledad Mountain Road Landslide
La Jolla, California

Project Number: 107069	Date: October 2010
Drafted: VN	Eng/Geo: SRH/RSA/MH
Scale: Not to Scale	Figure Number: 3A

INSTALLATION OF EAST SIDE SHORING REINFORCEMENT CAGE ON NORTH SIDE OF LANDSLIDE MASS

INSTALLATION OF EAST SIDE SHORING REINFORCEMENT CAGE ON SOUTH SIDE OF LANDSLIDE MASS

Helenschmidt Geotechnical, Inc.

Construction Photos

Soledad Mountain Road Landslide
La Jolla, California

Project Number: 107069	Date: October 2010
Drafted: VN	Eng/Geo: SRH/RSA/MH
Scale: Not to Scale	Figure Number: 3B

PLACEMENT OF CONCRETE FOR PANEL WALLS BETWEEN EAST SIDE SHORING

EXCAVATION OF SLOT 1 WITH COMPLETED PANEL WALL IN FOREGROUND

Helenschmidt Geotechnical, Inc.

Construction Photos

Soledad Mountain Road Landslide
La Jolla, California

Project Number: 107069	Date: October 2010
Drafted: VN	Eng/Geo: SRH/RSA/MH
Scale: Not to Scale	Figure Number: 3C

INSTALLATION OF PRESSURE TREATED LAGGING BETWEEN TEMPORARY SHORING IN SLOT 1

FILL PLACEMENT IN THE BOTTOM OF SLOT 1

Helenschmidt Geotechnical, Inc.

Construction Photos

Soledad Mountain Road Landslide
La Jolla, California

Project Number: 107069	Date: October 2010
Drafted: VN	Eng/Geo: SRH/RSA/MH
Scale: Not to Scale	Figure Number: 3D

FILL PLACEMENT ABOVE MIRAGRID 10XT IN SLOT 1

DRILLING OF KEYWAY SUBDRAIN OUTLET AT THE BOTTOM OF SLOT 2

Helenschmidt Geotechnical, Inc.

Construction Photos

Soledad Mountain Road Landslide
La Jolla, California

Project Number: 107069	Date: October 2010
Drafted: VN	Eng/Geo: SRH/RSA/MH
Scale: Not to Scale	Figure Number: 3E

COMPLETED SUBDRAIN IN SLOT 2 KEYWAY

GEOGRID PLACEMENT IN SLOT 2. EXCAVATION OF SLOT 3.

Helenschmidt Geotechnical, Inc.

Construction Photos

Soledad Mountain Road Landslide
La Jolla, California

Project Number: 107069	Date: October 2010
Drafted: VN	Eng/Geo: SRH/RSA/MH
Scale: Not to Scale	Figure Number: 3F

GEOGRID (MIRAGRID 10XT) AND FILL PLACEMENT IN SLOTS 2 AND 3

PLACEMENT OF MIRAFI HP570 AT ELEVATION 469' (APPROXIMATE)

Helenschmidt Geotechnical, Inc.

Construction Photos

Soledad Mountain Road Landslide
La Jolla, California

Project Number: 107069	Date: October 2010
Drafted: VN	Eng/Geo: SRH/RSA/MH
Scale: Not to Scale	Figure Number: 3G

SUBGRADE PREPARATION IN SOLEDAD MOUNTAIN ROAD AND CURB AND GUTTER CONSTRUCTION

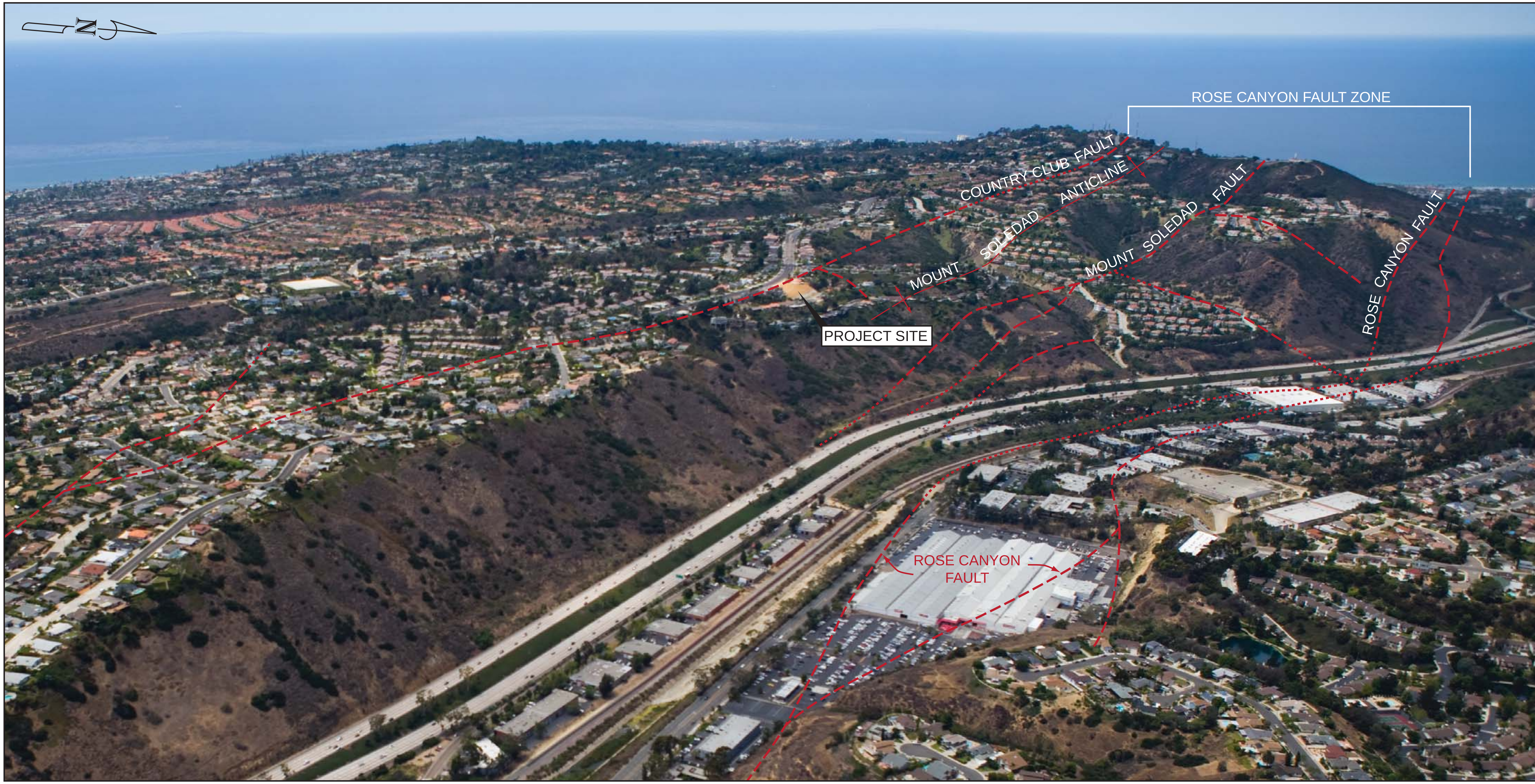
K-RAIL AND TEMPORARY FALL SLOPE ALONG EAST EDGE OF SOLEDAD MOUNTAIN ROAD

Helenschmidt Geotechnical, Inc.

Construction Photos

Soledad Mountain Road Landslide
La Jolla, California

Project Number: 107069	Date: October 2010
Drafted: VN	Eng/Geo: SRH/RSA/MH
Scale: Not to Scale	Figure Number: 3H



APPROXIMATELY LOCATED FAULT DOTTED WHERE CONCEALED

APPROXIMATE AXIS OF SOLEDAD MOUNTAIN ROAD ANTICLINE

*(ADAPTED FROM KENNEDY, CGS BULLETIN 200)

Helenschmidt Geotechnical, Inc.

Approximate Location of Rose Canyon Fault Zone

Soledad Mountain Road Landslide
La Jolla, California

Project Number: 107069	Date: October 2010
Drafted: VN	Eng/Geo: SRH/RSA/MH
Scale: Not to Scale	Figure Number: 4